

**TRACY FISH COLLECTION
FACILITY STUDIES
CALIFORNIA**

Volume 5

*Field Testing and Evaluation of a Video Image
Counting System for Fish Eggs in the Sacramento River
During May 1994*

July 1997

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Jim Arthur
Gary Jordan and staff
Scott Seigfried**

DENVER

**Charles Liston - Study Manager
Lloyd Hess
Steve Hiebert
Cathy Karp
Judy Lyons
Richard Wydoski**

**Field Testing and Evaluation of a Video Image
Counting System for Fish Eggs in the Sacramento River
During May 1994**

BY

Steven D. Hiebert¹, Edmond W. Holroyd III ², Richard G. Wydoski¹

TRACY FISH COLLECTION FACILITY STUDIES,

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UNITED STATES DEPARTMENT OF THE INTERIOR

BUREAU OF RECLAMATION

DENVER TECHNICAL SERVICES CENTER

¹Ecological Research and Investigations Group

²Remote Sensing and Geographical Information Group

AND

MID-PACIFIC REGION

South Central California Area Office

Tracy Office

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Tracy Fish Collection Facility Studies, California
Volume 5: Field Testing and Evaluation of a Video Image
Counting System for Fish Eggs in the Sacramento River
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PREFACE

The following report is the fifth volume in the Tracy Fish Collection Facility Studies series. These studies are investigating a variety of issues that are concerned with protecting and improving the overall fishery in the Delta—specifically at the Tracy Fish Collection Facility. The first volume summarized the 1991-1992 predator removal program and intake channel studies (Liston et al., 1994). The second volume summarized the 1991-1992 fish egg and larvae continuous sampling program (Hiebert, 1995). The third volume summarized the louver efficiency experiments at the fish facility in 1993 (Karp et al., 1995). The fourth volume examined factors affecting fish salvage estimates at the fish facility (Puckett et al., 1996). This study examines the use of special video-based imaging equipment to detect, distinguish, and count fish eggs in real-time. This technology could improve the existing continuous sampler designed and operated at the Tracy Fish Collection Facility by reducing manual labor to pick and identify eggs collected. This technology also has the potential to be used upstream of water diversions, monitoring eggs in real-time, and providing up-to-date information in making operational changes to reduce fish entrainment and allow developing eggs and larvae to move past the diversion and out to nursery areas in the Delta.

ABSTRACT

Since 1970, significant declines in striped bass have occurred in the Sacramento/San Joaquin River Delta. A possible factor contributing to this decline is that floating eggs and planktonic larvae are exposed to many water diversions where these early life stage fish could become entrained and lost to the system. A real-time monitoring system that could determine densities of these passing organisms would be valuable in alerting water managers to enact protective measures to reduce entrainment while these fish are present; then, when the organisms are passed, normal operations could continue. A special video-based identification and counting system—designed for the paper pulp industry—was tested for application in monitoring striped bass eggs. A system of concentrating the sampled Sacramento River water and presenting it to the Pulp Particle Measuring System (PPMS) was used to evaluate the ability to detect and count eggs, and to determine if estimates are comparable to traditional ichthyoplankton netting techniques. Large pulses of fish eggs passing through the sampler over the 30-day test were detected simultaneously by all three methods of sampling. Further refinement of data by correlations showed weak correlations. Recommendations for improving this technique to increase the confidence in counts and identification include:

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- ✓ Programming the counter identification system to make it specifically look for eggs rather than use the programs for determining paper pulp particle shape;
- ✓ Upgrading to a faster computer with the previous recommended programming on-board could keep the sampling continuous;
- ✓ Constructing an underwater concentrator out of wedgewire; and
- ✓ Providing dark background illumination on the imaged eggs to define the eggshells could greatly improve recognition capabilities.

This technology may have great potential in real-time in situ and laboratory sorting of fish eggs.

INTRODUCTION AND BACKGROUND

Increasing human populations in California have been accompanied by increasing demands for water, which have subjected fishery resources of the Central Valley to significant impacts. Since 1970, significant declines in striped bass (*Morone saxatilis*) have occurred in the Sacramento/ San Joaquin River Delta (Stevens et al., 1985). In response to this and other fishery concerns, several government and private study teams investigated possible reasons for the decline (Arthur et al., 1990; Odenweller and Brown, 1982; Spaar, S. A., 1990). One possible factor

contributing to the striped bass decline is that the floating eggs and planktonic larvae are exposed to many irrigation diversions (>1,800) where early life stages could be entrained and lost from the river system.

As part of studies to reduce entrainment loss of fish eggs and larvae in the river, real-time monitoring was determined most valuable because accurate, up-to-date information could be used to make short-term decisions on operations to reduce fish entrainment. Over the past 4 years, Bureau of Reclamation (Reclamation) biologists developed a device that continuously collects and preserves fish eggs and larvae (Hiebert, 1995). This continuous collection device provided samples around the clock. Data analysis was slow, however, due to the time required to manually pick fish eggs and larvae from the detritus and dirt in samples. To achieve the most from this sampler and acquire near real-time results, a video imaging and processing method was selected as potentially the most feasible method for sample collection and analysis. The sampler could now theoretically continuously monitor concentrations of eggs and larvae without the associated time-consuming task of manually picking samples. During 1993, several preliminary tests were performed in the Remote Sensing Laboratory, Denver, Colorado, and at Phoenix Technology, Inc., that in part measured sizes of eggs, shells, embryo and oil globules, and actually imaged eggs in static tests. These results were very promising, and a field trial was performed. This report presents the results of a study designed and performed by

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fish biologists and remote sensing specialists from Reclamation's Denver Technical Service Center investigating the use of a system to count buoyant striped bass eggs in the Sacramento River, California. Striped bass was the species of primary interest—it has declined in the recent years, is economically valuable, and uses the lower Sacramento River area as a nursery area once eggs and larvae make it downstream past the diversions (Chadwick, 1958). American shad (*Alosa sapidissima*) also spawn in the Sacramento River and, although their eggs are also buoyant, they are generally larger and without an oil globule (Wang, 1986) and should be discernable from the striped bass eggs with computer sizing analysis.

This study was done to select and test special video based imaging equipment and evaluate the methods to detect, distinguish, and count fish eggs in near real-time. This work was done in cooperation with the Reclamation's Division of Environmental Affairs Office in Sacramento and the U.S. Air Force, McClellan Airbase, California.

METHODS

The study site on the Sacramento River was at river mile 61.2 (River Kilometer Index No. RSAC178), which is about ½ mile upstream from the confluence with the American River. This site was on U.S. Air Force property with a dock that floated approximately 40 feet from the bank on the river. This "Air Force Site" was selected because of its position upstream from major irrigation control structures, high

probability of collecting eggs, good power availability, and large secured area to work over adequate water depth. Data from previous studies at nearby sites (Arthur et al., 1990) and personal communications with Doug Ball (Reclamation, Sacramento, California) indicated that a 30-day time period from May 1 to May 30 would be the best time for striped bass spawning and consequent egg sampling.

The video/computer system selected was leased from Phoenix Technology, Inc., Seattle, Washington. The Phoenix Technology PPMS is an imaging system that samples, detects, and measures particles (primarily dirt) that are considered contaminants in a stream of pulp slurry (Phoenix Technology, Inc., 1993). The system looks for objects that are in contrast to a backlit background and then performs a simple shape test to determine if the particle is long and thin (like a pulp fiber) or relatively round. Since the shells (chorion), embryo, and oil globules of striped bass eggs are all relatively round in contrast to most detritus (longer than wider), the Phoenix system with the capabilities to detect shapes and count them in near real-time was selected for this study.

The Phoenix PPMS was installed at the discharge end of a continuous egg collection system. The basic egg collection system consisted of a "delicate solids" pump with an internal helix impeller that pumped river water concentrated at the back of a pair of 1-meter-diameter ichthyoplankton nets through a

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dewatering/ concentrating box containing 500-micron wedgewire screen (Figures 1 and 2). The PPMS was plumbed into the concentrated discharge from the collection system. Multistage filtering—accomplished by the nets and screen—was necessary to concentrate eggs for presentation to the relatively small (30- by 42- by 5-mm, 63-ml) sample viewing cell. The concentration factor from the nets (31:1) was multiplied by the dewatering box factor (200:1), to estimate a total final concentrate of approximately 6200:1 to the imaging cell. The PPMS system operated automatically, drawing in the sample concentrate, imaging it, analyzing the image, and expelling the sample while drawing in another sample. The computer system recorded the counts and displayed a histogram over time of what passed through the imaging system by size group, and provided rough estimates of egg concentrations in the river. Discharged samples from the PPMS were collected in 500-micron nets, preserved, and stored in sample bottles for later analysis for comparisons with a conventional net sampler and the computer record.

The system was operated from May 3 to May 26, 1994, primarily during daylight hours. Samples of eggs were also collected with a conventional ichthyoplankton meter net for comparison with the PPMS counts. This net had a 0.5-meter-diameter mouth with 500-micron mesh and a flowmeter mounted off center in the mouth of the net. The net was fished at the beginning of every collection test for 15 minutes and then periodically through the duration of the test. The

discharge samples from the PPMS were also collected simultaneously to these samples. These ichthyoplankton samples were preserved and stored for later analysis. Tests were also performed periodically with a known number of eggs to verify this system and possibly increase the accuracy of the extrapolation to egg density in the river. Preserved samples were processed in the laboratory; eggs and larvae were separated from the detritus, counted, and recorded.

RESULTS AND DISCUSSION

A total of 216 samples were collected and analyzed from the PPMS discharge and conventional ichthyoplankton net. Results from each preserved sample were divided into nine classifications, and results by computer sizing were detailed into four classifications, as shown in Table 1. The computer results were obtained through a detailed method using specific computer programs designed to extract the egg count data from the standard PPMS data files (Holroyd, 1995).

A total of 9,495 eggs and 4,715 prolarvae were processed from the ichthyoplankton and PPMS discharge samples. Other larval species removed from samples—but not analyzed—included threadfin shad (*Dorosoma petenense*), centrarchids, cyprinids, and smelt (Osmeridae). Table 2 presents the counts of striped bass eggs and prolarvae along with the ratio of live to dead eggs collected by netting and at the PPMS discharge.

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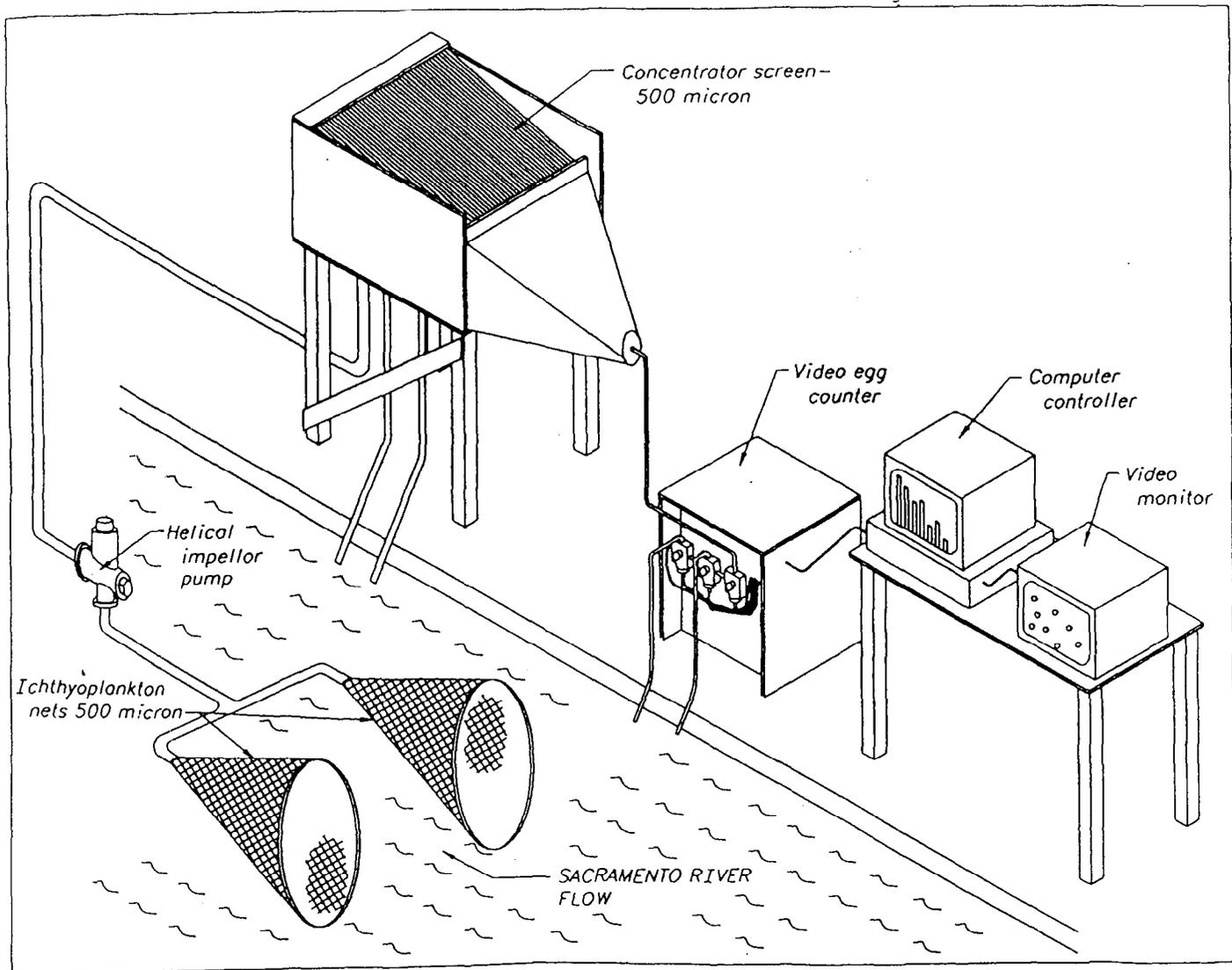


Figure 1. Schematic of the egg collection and counting system used in this study.

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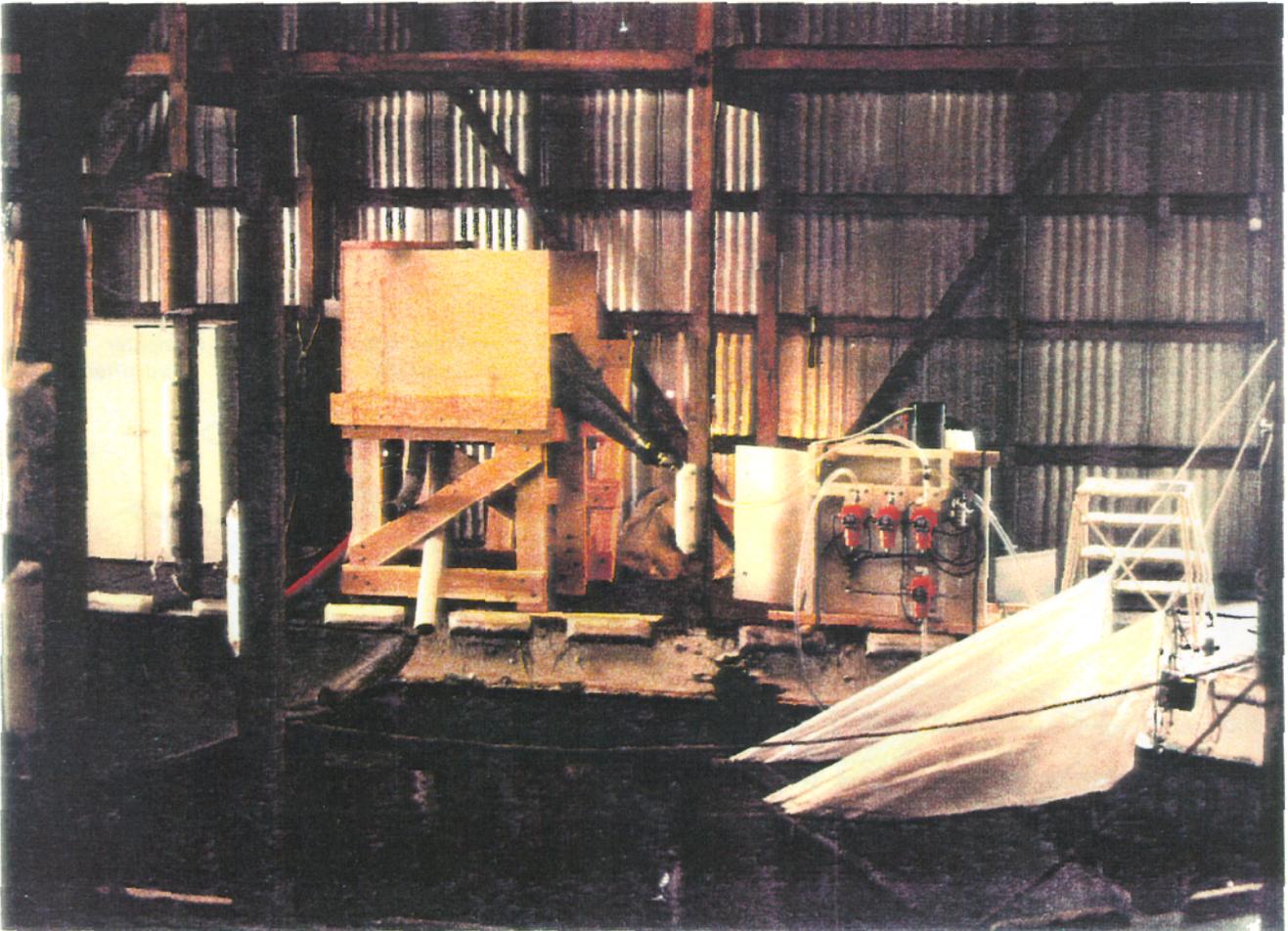


Figure 2. Egg collection and counting system set up over the Sacramento River, May 1994.

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Table 1. Sample classification groups and abbreviations used in analysis of the video fish egg counter.

Classification	PPMS discharge	Net	Computer
Total eggs	P-eggs	N-eggs	
Striped bass eggs live	P-sbel	N-sbel	
Striped bass eggs dead	P-sbed	N-sbed	
Striped bass prolarvae	P-sbpl	N-sbpl	
Striped bass larvae	P-sbl	N-sbl	
American shad eggs live	P-asel	N-asel	
American shad eggs dead	P-ased	N-ased	
American shad larvae	P-asl	N-asl	
Prickly sculpin larvae	P-psl	N-psl	
Striped bass oil+yolks**			sboy
Striped bass oil globules			sbo
Striped bass yolks**			sby
American shad yolks**			asy
** Yolks included the developing embryo within the eggshell			

Table 2. Numbers of striped bass eggs and prolarvae collected during the study.

	Total striped bass eggs	Ratio live:dead striper eggs	Striped bass prolarvae	Total American shad eggs	Ratio live:dead shad eggs
PPMS discharge	5,075	0.9 : 1	182	401	4.5 : 1
Ichthyo nets	4,420	3.0 : 1	4,533	64	63 : 1

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There was a large difference in the ratio of live to dead eggs and the total of striped bass prolarvae between the two samplers. The PPMS samples contained more dead than live striped bass eggs, indicating the system—including the pump and concentration filtering system—was impacting and killing more eggs compared to the ichthyoplankton net. Also, the striped bass prolarvae were at a very fragile, soft stage that may not have been retained effectively by the 500-micron wedgewire screen. Fewer American shad eggs were collected. American shad eggs exhibited higher alive to dead ratios than did striped bass eggs, indicating that shad eggs may be tougher and not subject to as high a mortality after impacts or pressure changes.

Known numbers of striped bass eggs were run through the submersed pump and PPMS and then retrieved from the PPMS discharge, primarily to evaluate damage and loss of eggs through the plumbing and valves but also to observe the eggs on the video screen and note the computer count. Because the PPMS bypasses the sample stream during a 6+ second image analysis, no relationship to the computer estimates was performed on such small samples. Appendix A presents the results of the tests with eggs injected into different parts of the collection system. Between 68 and 90 percent of the eggs were recovered at the PPMS discharge. The eggs passing through only the headbox and PPMS resulted in about a 20-percent loss with the net and pump adding around 10 percent to the loss. These losses could be reduced considerably with modifications to the system.

Two pulses of striped bass eggs in the Sacramento River were recorded over the test period. These were probably related to warmer temperatures upstream inducing some spawning. These pulses covered several days with the first peak occurring May 11, 1994, at about 0.5 eggs per cubic meter of water and the second peak on May 23, 1994, at about 0.3 eggs per cubic meter.

Figure 3 presents results of simultaneous samples from all three data sets (netted, PPMS discharge, computer). Although amplitude is different between results, and there is high variability in the lower egg numbers, the two large pulses are present in all data, but offset up to 11 samples (approximately 2 days). This demonstrates a degree of comparability and ability to detect large pulses and thresholds.

To attempt further refinement and quantification of data, correlation analysis was performed between the conventional ichthyoplankton net results and eggs collected from the PPMS discharge. Since both samples were collected at the same depths simultaneously, they should have some relationship. The large peaks and some smaller spikes are similar (Figure 3), but a Pearson Correlation of total eggs found in each method showed weak relationships.

In further analysis of the computer optical counts, an obvious and permanent decrease in counts occurred May 14, 1994. Although it is unknown what caused that decrease (possibly intake modifications and or sample cell

Comparison of Three Data Sets Sacramento River Samples, May 1994

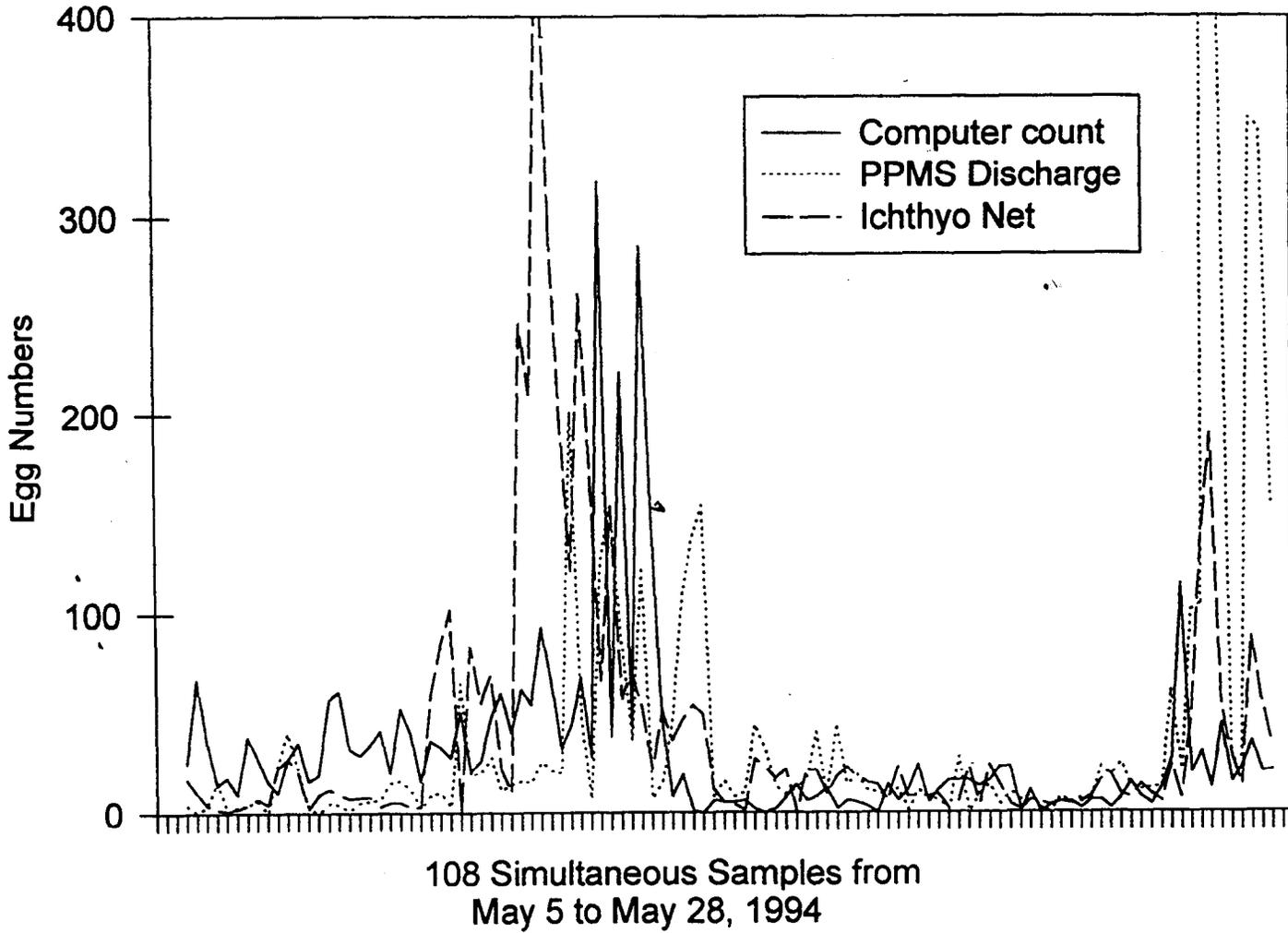


Figure 3. Graph of simultaneous data from the ichthyoplankton net, the collected discharge from the PPMS, and the computer optical counts.

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reorientation), a correlation analysis was done on data grouped up to May 14 and after May 14. Table 3 presents the correlation coefficients for all eggs and eggs collected after May 14. After May 14, correlation was relatively high at 0.832 between the netted

eggs and the PPMS discharge eggs. The other striped bass correlations increased somewhat, and American shad correlations remained weak.

Table 3. Correlation coefficients between the ichthyoplankton net and the PPMS discharge samples for all samples and for only samples collected after May 14.

Classification	PPMS	Net	Correlation Coefficients	
			All samples	After May 14
Total eggs	P-eggs	N-eggs	0.326	0.832
Striped bass eggs live	P-sbel	N-sbel	0.287	0.830
Striped bass eggs dead	P-sbed	N-sbed	0.070	0.307
Striped bass prolarvae	P-sbpl	N-sbpl	0.240	0.341
Striped bass larvae	P-sbl	N-sbl	0.225	0.245
American shad eggs live	P-asel	N-asel	0.082	0.001
American shad eggs dead	P-ased	N-ased	0.019	M
American shad larvae	P-asl	N-asl	0.447	0.466
Prickly sculpin larvae	P-psl	N-psl	0.220	0.138

M = Coefficient cannot be computed.

Since the computer was counting different sized objects, a correlation with the PPMS discharge was performed to see if size data

were related within egg size classes. These correlations are presented in Table 4.

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Table 4. The correlation coefficients between PPMS discharge eggs (eggs) and striped bass eggs live (sbel) and the computer counts at the various optical sizes (mm²). The larger correlations are highlighted.

Size	Eggs	sbel	Size	Eggs	sbel	Size	Eggs	sbel
>5.0	.174	.043	.80	.106	.057	.09	.154	-
5.0	-.049	-.029	.60	-.023	-.013	.08	.170	-
4.0	.211	.247	.40	.181	.066	.07	.180	-
3.0	.280	.299	.30	.249	.078	.06	.151	-
2.5	.060	-.016	.25	.179	.033	.05	.184	-
2.0	.037	.001	.20	.229	.048	.04	.198	-
1.5	.285	.254	.15	.186	.009	.03	.175	-
1.0	.120	.030	.10	.187	.036	.02	.188	-

The larger sizes might be corresponding to something within the eggs. The smaller sizes (<2.0) should have no correlation with the eggs. The "eggs" class has not only live striped bass eggs, but also dead ones and American shad eggs—both dead and live. Those extra classes probably contribute to the difficulty in finding appreciably different correlations for the "eggs" class. The "sbel" class has much greater distinction between the higher and lower correlation coefficients. The largest correlation values are at the 4.0-, 3.0-, 1.5-, and 0.3-mm² sizes. Those are appropriate sizes for striped bass yolks and oil globules (visible in live eggs but not in dead ones), which were highlighted in the bright field illumination within the sample cell.

Table 3 shows promise that certain sizes are indeed indicators of optical recognition of the striped bass yolks and oil globules, but the low correlations in general indicate more resolution is needed in the system.

The generally low correlations indicate that the optical data had difficulty discerning—by its size classifications—what the system was really looking at. Most likely, there was other debris in the water that had a similar size. There was no attempt to confirm the presence of an eggshell around particles of this size. Such a confirmation needs to be done in the future. Figures in Appendix B show two identical video images with a live and dead striped bass egg and how the computer

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detected them. The more opaque, dead egg was entirely detected, and only the embryo within the shell was detected in the live egg.

Cleaning of the twin 1-meter intake nets was necessary following every test; consequently, concentration factors from nets were not constant. This probably contributed to the lack of correlation in the PPMS discharge and the ichthyoplankton net results. Figure 4 illustrates a downward curve of volume of river water sampled over time. It appears that the nets quickly clog within 50 minutes and then are saturated with probably very little filtration during the remainder of the sampling. Much of the net fouling material was impinged cottonwood tree seeds. In an effort to determine some effects of net fouling, correlations were performed on data collected only on samples taken immediately after the net was cleaned. Appendix C from Holroyd, 1995, presents the correlation matrix with the computer optical counts correlated with both PPMS discharge and netting results. The net cleaning improved the correlations for most categories but still did not bring any up to strong relationships (>0.65).

From the tests with known numbers of eggs injected at various points, there is damage to some of the eggs as they pass through the system. A source of possible damage is the impact of eggs on the fixed wedgewire incline screen with its hard surface combined with high discharge and angle of impingement. This is in addition to pressure changes within the PPMS control valves. The pressures within the PPMS fluctuate as the PPMS

abruptly stops the flow through the sample viewing cell for 6 seconds to let the particles stop moving before imaging. This stop-and-start routine and the pressures associated could be destructive to the eggs. The total egg counts from netting and PPMS discharge also support this with more dead than live eggs in the PPMS discharge.

There was a varying rate of flows of concentrate to the PPMS that was determined by flows across the inclined wedgewire screen. As the screen clogged or inflow changed—because of river velocity—the adapter funnel that connected to the PPMS either flooded or contained only flow-through concentrate (most desirable). These changes in amounts of water in the funnel changed the dilution and flow of concentrate to the PPMS. With modification, this could be made a fairly constant rate of flow to the PPMS.

The only major improvement performed during testing was to redesign and change how the twin large nets were plumbed to the submerged, delicate solids pump. Pump inflow appeared to be restricted by clogged netting bunching up in the pump intake. Under this condition, the pump "recycles," to some degree, the river water, and eggs are exposed to the impellers for a greater period of time. Changing the approach angle (more acute) of water to the impeller also exposes the eggs to impeller damage. When the pump is operating at designed optimum efficiency (no restrictions, full flow), the damage to pumped material is the lowest.

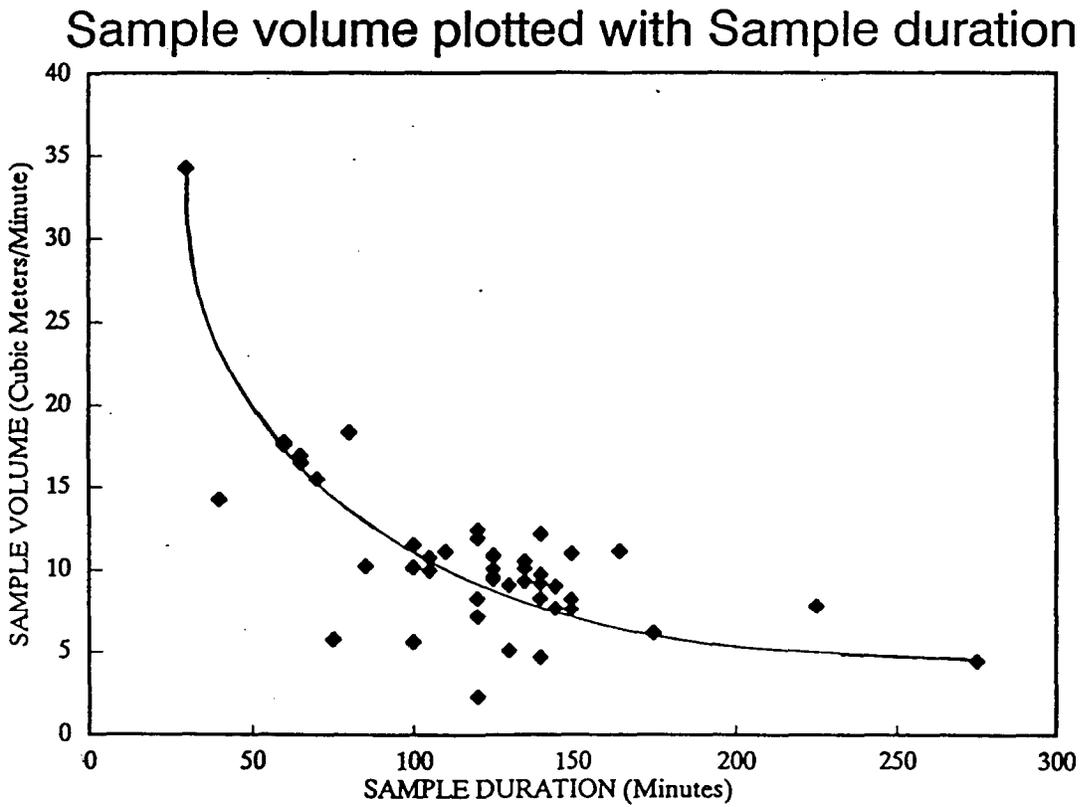


Figure 4. Graph showing comparison over time of the volume filtered through the ichthyoplankton nets and the duration of the samples taken during May 1994. The line plot is an extrapolated curve to fit the points.

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Within the PPMS, there were some operations that could be changed to increase sample handling accuracy. Filamentous detritus and/or an abundance of particles in the viewed sample slowed the scanning analysis considerably. When a sample is in the sample cell, the PPMS is bypassing the concentrate. Therefore, if the system is taking a long time to scan the image, a lot of concentrate is bypassing back into the river. A computer with a faster processor and video boards would alleviate this problem.

CONCLUSIONS AND RECOMMENDATIONS

The low correlations between the computer analysis, PPMS discharge samples, and netted samples suggest this technology needs refinement before it is suitable for egg counting. However, higher correlations are within the ranges for striped bass egg oil globules and embryos, and modifications are relatively straightforward and relatively easy to perform. A caveat to this evaluation is that the video/computer counter was an "off-the-shelf" pulp particle measuring system with only small hardware modification to count eggs in near real-time.

Recommendations for improving egg handling and counting accuracy are as follows:

- ✓ At the onset of this study, Phoenix Technology, Inc., was working on egg-specific programming that would find the oil globule or embryo shape and then look

for a shell around them to verify the particle as an egg. This refinement was not completed before this study. If this shell-determining software could be incorporated into an egg counting system, then a more accurate count would be possible.

- ✓ The present software size bins only go up to 5 mm². All objects with more than 5-mm² size are lumped into the last >5-mm² bin. To accurately count and size eggs and discern American shad from striped bass eggs, the size categories used in the software should be increased to 10 mm².
- ✓ Laboratory trials with various lighting techniques and eggs performed at the Remote Sensing Laboratory in Denver demonstrated that dark field (background) illumination— with forward scattering of the light—highlighted the eggshell very well. This modification was also not included in these tests, but should be included in an egg counter to greatly complement the previous software's ability to find an eggshell.
- ✓ Faster computer and image processing boards are needed to keep sampling continuous. With the previously listed software refinements to increase logic software for eggshell detection, it becomes even more important to increase computing capacity and speed.

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- ✓ An underwater concentration filter should be constructed out of wedgewire screen and plumbed into the intake of the delicate solids pump. This smooth, ridged, self-cleaning screen could be funnel-shaped or V-shaped and be sized to provide at least a 30-to-1 concentration.
- ✓ Adjustments should be made to the discharge of the dewatering box so that concentrated river water is presented to the imaging system at a constant rate with no backup of water or changes in rate of flow through the imaging cell.
- ✓ The utility of a real-time egg collection and counting device would be to setup continuous samplers at key fixed points in the Sacramento River during expected spawning seasons and determine peak periods of drifting eggs and larvae. This could lead to modifications of water diversion operations that should minimize

entrainment losses. This ability to image fish eggs—and possibly larvae—is not limited to striped bass or smaller life stages. It could be valuable at projects where loss of any life stages of fish could be reduced with knowledge of the organisms' movements on a real-time basis.

In addition, the application of the imaging techniques of this system could be applied to analyze collected, preserved, and stained samples from conventional netting and continuous samplers, thus cutting down considerably the "bottleneck" in hand-picking samples we now have.

In general, use of these techniques and equipment ultimately can lead to more data on fish populations that contribute toward minimizing fish loss and improving fisheries.

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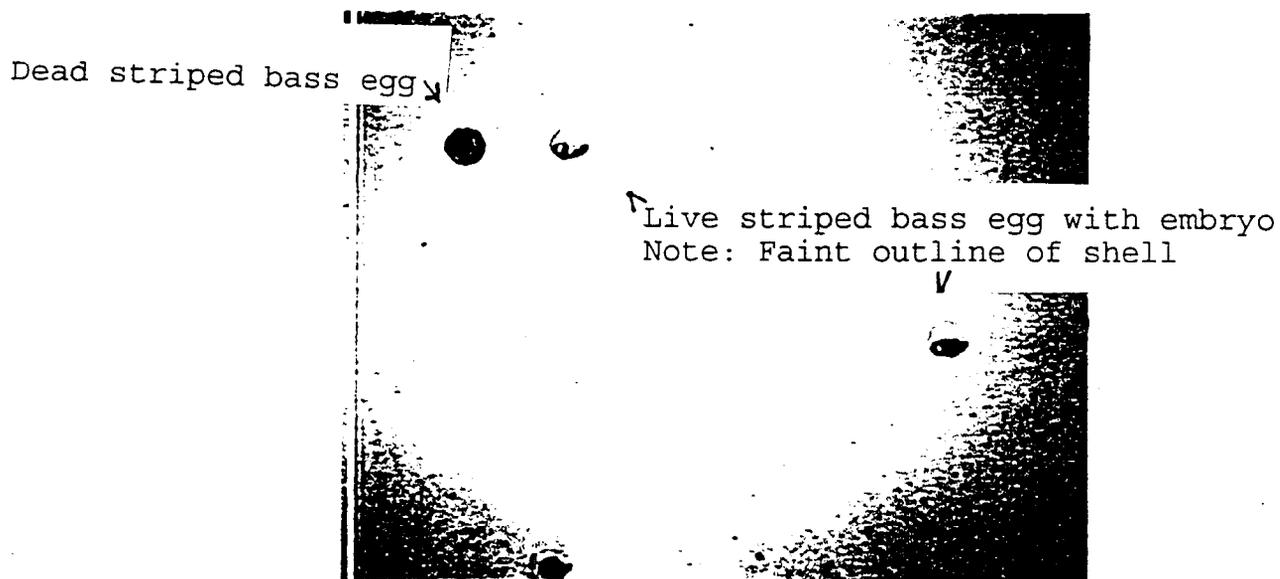
Appendix A. Results from egg collection tests performed with known numbers of eggs passed through various points in the collection/counting system and retrieved from the discharge of the PPMS, May 1994.

Test type	Duration	Number of eggs	Recovered percentage
Eggs injected into pump intake	10 minutes	50	68%
Eggs injected into pump intake	10 minutes	50	82%
Eggs placed in headbox	10 minutes	50	78%
Eggs placed in headbox	6 minutes	50	82%
Eggs placed in after headbox	30 minutes	50	78%
Eggs placed in recovery net	10 minutes	50	100%
Eggs placed into net mouths after 10 minutes of operation	30 minutes	200	94%
Eggs placed into PPMS intake funnel	1 hours 10 minutes	2500	only observed on video*

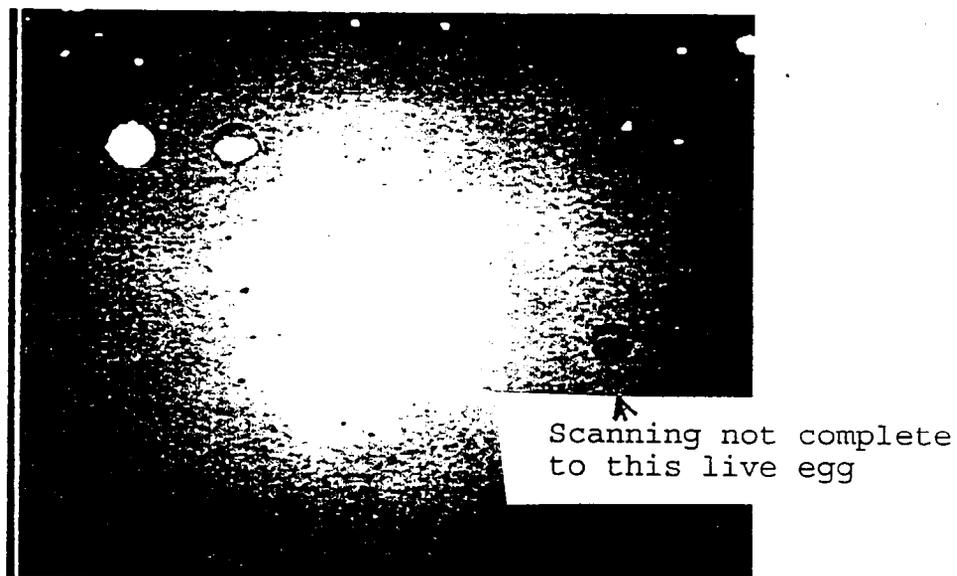
* Observations included notes that elliptical shaped embryo (with and without shells) are rarely counted by the computer.

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Appendix B. Photographs taken from the video screen of striped bass eggs being scanned.



Video image before scanning



Computer scanned video of live and
dead striped bass eggs.

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Appendix C. Correlation coefficients between physical sample characteristics and optical size ranges. The classification abbreviations were given in Table 1. The upper part of the table is for all 108 samples. The lower part is for only those 33 samples that were made after a cleaning of the nets. Relationships for which the correlations are expected to be best because of chosen size range are underlined. The better sets are highlighted in bold.

108 Samples

Optical:	sboy	sbo	sby	asy	sboy	sbo	sby	asy
Class	PPMS discharge				Net			
eggs	<u>.217</u>	<u>.213</u>	<u>.206</u>	(.342)	<u>.110</u>	<u>.108</u>	<u>.041</u>	(.212)
sbel	(.085)	<u>.081</u>	<u>.132</u>	.311)	<u>.085</u>	<u>.083</u>	<u>.035</u>	(.169)
sbed	<u>.197</u>	<u>.196</u>	<u>.153</u>	(.204)	<u>.104</u>	<u>.102</u>	<u>-.004</u>	(.221)
sbpl	(-.062)	-.063	-.020	.065)	<u>.095</u>	<u>.095</u>	<u>-.001</u>	(.064)
sbl	(.154)	.153	.123	<u>.263</u>)	<u>.055</u>	<u>.053</u>	<u>.056</u>	(.094)
asel	(.207)	.207	.317	<u>.029</u>	.323	.321	.168	<u>.134</u>)
ased	(.023)	.022	.030	<u>-.109</u>	.313	.315	.323	<u>.220</u>)
asl	(-.004)	-.003	.027	<u>.181</u>	.041	.042	.065	<u>.102</u>)
psl	(.050)	.050	.039	.062	.164	.163	.053	.079)

33 Samples

Optical:	sboy	sbo	sby	asy	sboy	sbo	sby	asy
Class	PPMS discharge				Net			
eggs	<u>.356</u>	<u>.357</u>	<u>.270</u>	(.638)	<u>.280</u>	<u>.280</u>	<u>.115</u>	(.258)
sbel	<u>.153</u>	<u>.154</u>	<u>.132</u>	(.514)	<u>.221</u>	<u>.221</u>	<u>.089</u>	(.275)
sbed	<u>.362</u>	<u>.363</u>	<u>.220</u>	(.527)	<u>.391</u>	<u>.312</u>	<u>-.176</u>	(.082)
sbpl	(-.070)	-.070	-.013	.208)	<u>.366</u>	<u>.365</u>	<u>-.074</u>	(.221)
sbl	(.478)	.476	.323	<u>.316</u>)	.711	.710	.505	<u>.442</u>)
asel	<u>.217</u>	<u>.218</u>	<u>.468</u>	(.027)	.547	.549	.153	<u>.384</u>)
ased	(.128)	.128	.008	<u>-.131</u>	.000	.000	.000	<u>.000</u>)
asl	(-.134)	-.134	-.125	<u>.119</u>	.048	.050	.082	<u>.049</u>)
psl	(.076)	.078	.117	.117	.306	.306	.134	.008)

Parentheses indicate data sets with median values of only one egg or larvae and should be ignored as statistically unreliable.